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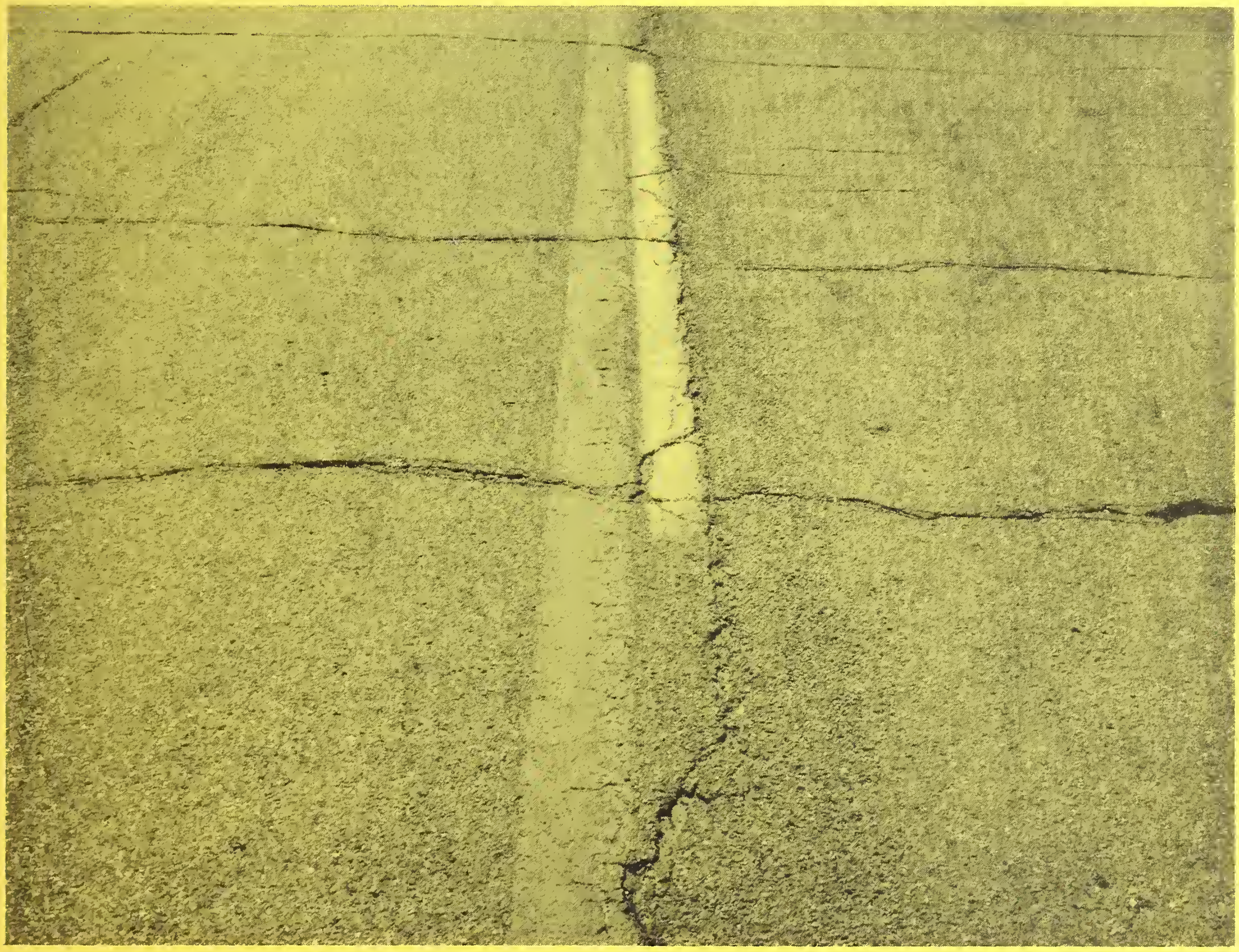

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FINAL REPORT

PAVEMENT CRACKING IN MONTANA

For The
State of Montana
Department of Highways
Planning & Research Bureau

In Cooperation With The
U.S. Department of Transportation
Federal Highway Administration

By
Edward A. Nurse
President
and
Robert M. Smith
Soils Engineer

Foundation and Materials Consultants, Inc.
Helena, Montana
August 1971

The opinions, findings and conclusions expressed in this publication are those of the author and not necessarily those of the Federal Highway Administration and the State of Montana Department of Highways.

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ABSTRACT

A study of asphalt pavement cracking was initiated in Montana as a means of approach to the problem of plant mix pavement deterioration. Correlations were made of data presently available in construction and laboratory report files as well as information collected from a field review of each project. Engineers envisioned that possibly certain conditions would be common for those projects which have given excellent service, while other conditions might be common for those projects showing premature cracking.

Data from approximately four hundred plant mixed asphalt pavement projects were analyzed by an outside materials consulting firm after being gathered by Highway Department personnel. Data obtained included age, most recent traffic count, pavement thickness, asphalt type and supplier, gradation and dust ratio and Marshall mix design data.

Each project was field rated as to appearance, ride, settlement, raveling and rutting. Longitudinal and transverse cracking was rated by frequency and severity in each quarter mile segment. Projects studied were on the Interstate, primary or secondary systems.

The study failed to produce any correlations, which could be used by design, materials or construction personnel. Good correlations were achieved in a few instances where the data was stratified by dividing the State into areas of similar geology and geography, pavement age and traffic conditions, but in these cases, the sample size was insufficient to be statistically significant.

The study did not include taking core samples and checking field void content, asphalt content, dust ratio, deflection, etc., which have been useful in explaining premature cracking in other studies.

The data will provide a base for further study in pavement deterioration. It is believed that future studies of this nature should not include as many projects, but rather a more penetrating study of a few selected projects.

INTRODUCTION

This report contains the results of a Highway research program sponsored by the Montana State Highway Commission and the Department of Transportation through the Federal Highway Administration.

Montana has experienced a problem of cracking of asphalt pavement which is intermittent and variable in frequency and severity. Where serious cracking occurs, premature and expensive maintenance is required.

Adjoining states and Canada have experienced similar problems. Their approaches to the problem have been studied and the findings incorporated into the data gathering phase of this study, and into the analysis where possible.

The scope of the present project was limited to a visual inspection and rating of 400 projects covering the Interstate, Primary and Secondary highway systems, and a search of the records for information recorded at the time of construction. All data were coded and stored on tape. In addition, pictures were taken of the typical condition of the pavement on each project.

The principal objectives were to ascertain, if possible from the available information, what variables controlled pavement cracking and to recommend the direction in which further research, if needed, should progress.

These objectives were tentatively subdivided into the following steps.

(1) A literature search of similar studies to determine the type and form of data gathering.

(2) Data search of 400 project records.

(3) Field examination and rating of each 1/4 mile segment in each project. The data obtained was averaged for the project as a whole.

(4) Evaluation of the rating system with respect to its adequacy as a measure of cracking.

(5) A statistical analysis of the rating system versus variables recorded in the record search if determined useful.

(6) A statistical analysis of cracking frequency and percentages versus variables to obtain a model representing the most significant variables influencing pavement cracking.

(7) Conclusions and Recommendations, including formulas predicting pavement performance, if statistical evidence is found to support such formulation, and recommendations for further study.

Steps 4, 5 and 6 are anticipated to make use of the "Stepwise Multiple Regression" program in testing the significance of the several variables. Use of the program, however, depends upon a study of the individual scatter diagrams of the independent variables to eliminate the variables which are not truly independent.

As the investigation progressed, several changes in the method of study were judged applicable. Limited use was made of the multiple regression analysis, after studying the individual scatter diagrams, a sample of which are included herein as figures.

The report is composed of a single "chapter" with the seven steps listed above as main headings. One quarterly report and 5 monthly reports were submitted during the portion of the investigation performed by the writers. Periodic meetings were held with the Montana Highway Commission and the Federal Highway Administration to assess the progress and to agree on the changes in method of analysis.

Examples of the format for field examination and data storage are appended.

Basically, three employees of Foundation & Materials Consultants were employed on the project: Edward A. Nurse, P.E., Robert M. Smith, P.E. and Gary K. Robinson, EIT. Field investigations and the Record Search were carried out under the direction of Homer Wheeler, Assistant State Highway Engineer, by largely temporary personnel during the spring, summer and early fall of 1970. Edward Miller, Technical Monitor, and Research Engineer, Montana State Highway Commission, and the data processing Section contributed greatly in direction and in preparation of data for computer analysis. Representatives of both the Montana State Highway Commission and the Federal Highway Administration gave valuable advice and assistance.

LITERATURE SEARCH

Pavement cracking studies and serviceability rating studies performed in Wyoming, Utah, Idaho, Washington and Saskatchewan, Canada, were utilized as reference for setting up the field study and record search. These references and others consulted during the course of the investigation are referred to in the text where applicable.

RECORD SEARCH AND FIELD STUDY

In most cases individual ratings and measurements of cracking frequency were made on each quarter mile segment of each project. The existance of joint cracks, alligator cracks, ravelling, rutting, settlement and other distortions in the pavement were noted. Ratings and frequency of cracking were averaged for each project and the other distortions recorded as a percentage of the quarter-mile segments affected.

Following are the code numbers used to designate various parameters and definitions used in this investigation:

Transverse Crack Frequency

1. Negligible Cracking
2. 100 ft. to 500 ft. spacing
3. 20 to 100 ft. spacing
4. 10 to 20 ft. spacing
5. One crack or more every 10 ft.

Longitudinal Crack Frequency

Type #1 construction joints

Type #2 non-construction joints

1. 1 crack per two lane width
2. 1 crack per lane
3. 1 crack per lane interlaced or tendrils
4. Multiple cracks per lane
5. Severe

Width of Cracks

1. Hairline to 1/8 in.
2. 1/8 to 3/8 in.
3. 3/8 in. or greater

Other crack types and distortions are expressed as a percentage of the quarter mile segments in which the distress occurs. Typical field work sheets are appended.

A search of the records resulted in data covering date of construction, asphalt grade, asphalt mix gradation and dust ratio, percentage of asphalt, supplier, Marshall data (Voids %, flow, and stability), pavement structure thickness, traffic, asphalt mix, air temperature, and mineral filler type and amount.

The data accumulated consists of single values for each of the above variables per project. In the case of gradation and asphalt mix properties, these may be averages of construction records or more likely laboratory mix design values. For many projects some variables are missing, and in no case was information on the subgrade recorded.

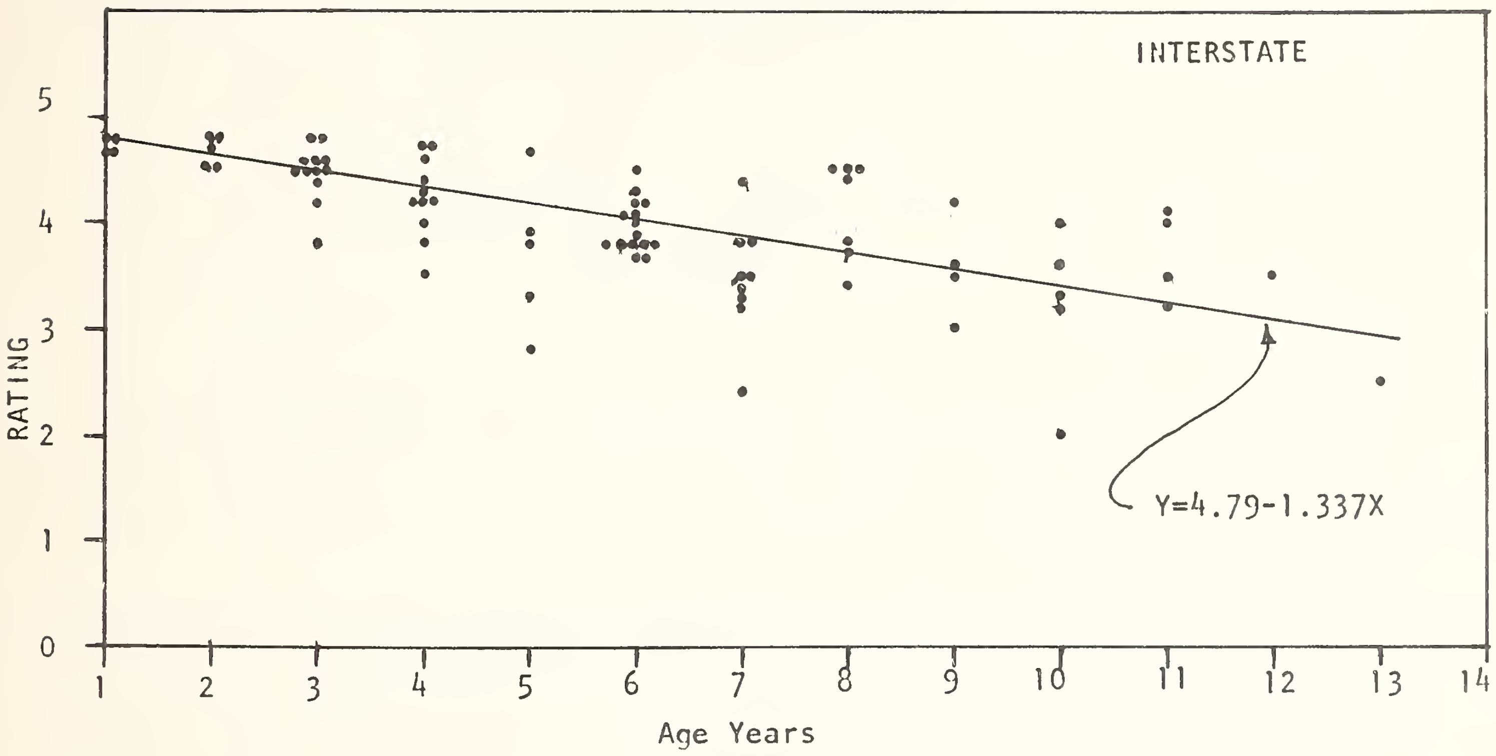
Data storage on punch cards is as shown in the appended sample. A change was made in the data format to include pavement age directly.

EVALUATION OF RATING SYSTEM

The evaluation of the rating system was undertaken to ascertain the validity of the rating as a measure of the overall pavement condition. The State of Utah (1) utilized the roughness and cracking frequency to annually arrive at a serviceability index or rating. Construction records were reviewed to arrive at a construction index. Where the Construction Index was high, the correlation between rating and age was good. The State of Washington rating system weighted appearance and ride, resulting in a single rating for a project (7). Plotted against age, the rating showed good correlation, but was not linear. The field evaluation used in this study is similar to that used in Idaho. The Idaho study (2) related rating to riding quality. Riding quality was found to be affected only slightly by the mere existance of cracks, and neither age nor traffic correlated well with riding quality.

Based on the Idaho study, the rating based on ride was eliminated as a dependent variable in the study of cracking in Montana.

The first step in this investigation was a linear correlation of age with appearance rating. Figure 1 shows the scatter diagram and linear best fit for the Interstate and Primary Systems. The variation is quite high, similar to that for riding quality versus age in the Idaho Report (2). Correlation coefficients computed using "Stepwise Multiple Correlation" with a dummy variable, were .640 for the Interstate and .492 for the Primary System, neither of which is particularly good.



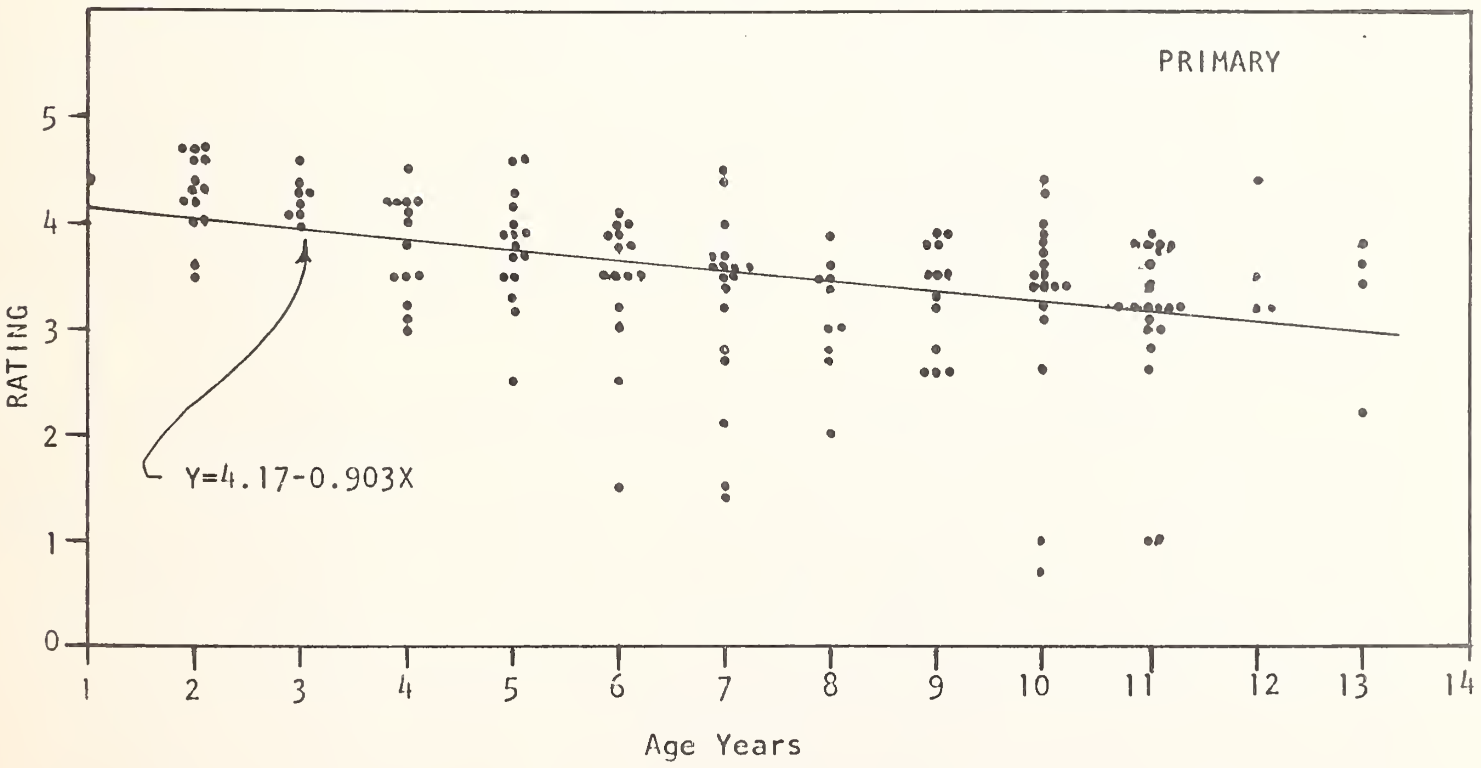


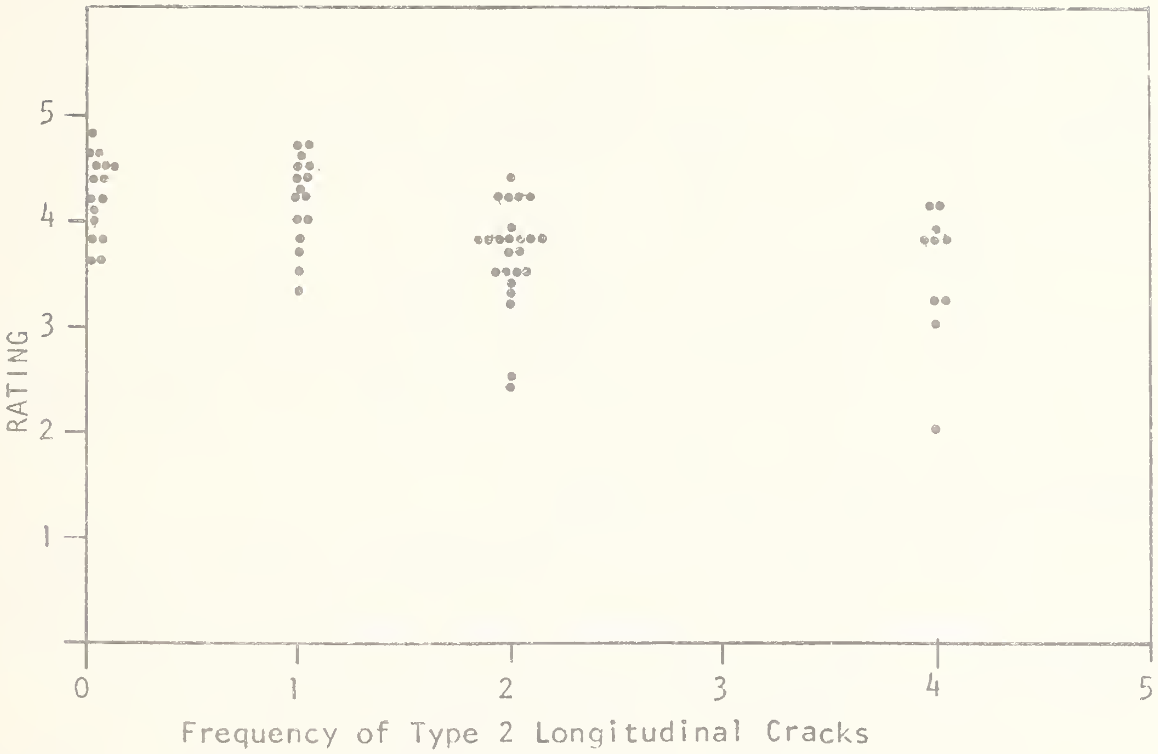
FIGURE 1. Comparison of Appearance Rating and Age

At this point, some problems were discovered which drastically changed the methods of investigation. First, because stratification of the data based on class of highway was desirable, external sorting requiring the use of the cards rather than tape storage was necessary. Incomplete data for some variables made additional sorting necessary before a sample size could be ascertained for each computer run. This added measureably to the cost and to the turn around time. Hand plotting was chosen, therefore, for the remainder of the scatter diagrams utilizing a computer printout of the stored data. Multiple regression analyses were to be delayed until sufficient graphs were drawn to insure that only data showing some visual correlation would be used.

Another factor entering into reduced useage of the "Stepwise Multiple Regression" program is that it is based on a linear correlation model, and a straight line correlation is not estimated to be as common with these types of data as second, third power or logarithmic curves. (Refer to Serviceability Index formulas presented in Reference 3.)

Figure 2, illustrates the relationship between crack frequency and rating for the Interstate System. A very slight trend may be present but the dispersion is very high. Any correlation would have a very high coefficient of variation.

At a meeting with representatives of the Montana Highway Commission and the Federal Highway Administration, it was decided that although the rating system may describe the overall condition of a project, its use as a variable in determining the causes of premature cracking is negligible. In general, the average rating is quite high, while a high proportion of projects exhibit moderate to high crack frequency. In the remainder of the investigation cracking frequency is used as the dependent variable. Step 5 of the principal objectives was as a result deleted.



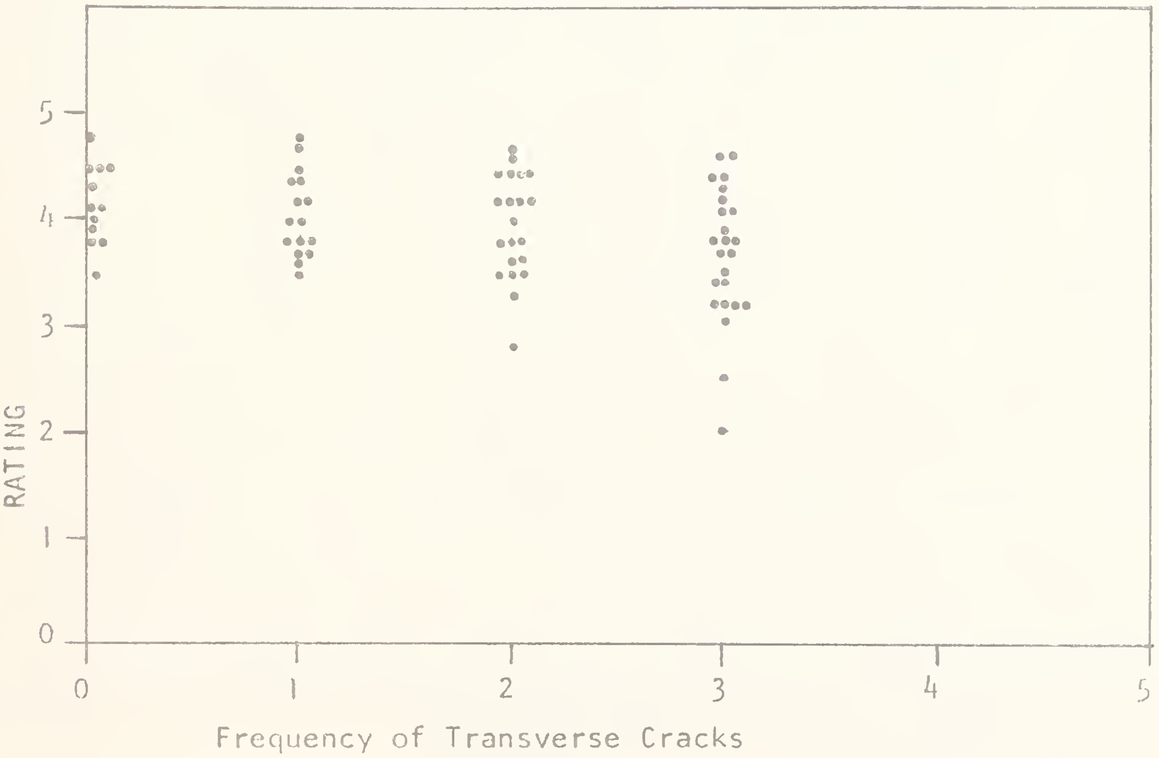


FIGURE 2. Comparison of Frequency of Cracking and Rating System

ANALYSIS OF CRACKING VERSUS ASPHALT MIX PROPERTIES, TRAFFIC AND AGE

For the remainder of this protion of the investigation, Transverse crack frequency, and Type 2, Longitudinal crack frequency will be used as dependent variables. Alligator cracking is present on only a few Interstate projects studies and transverse crack width is relatively constant.

In most instances, all available data is used; however, there may be some benefit in eliminating projects with less than 50% of the quarter mile sections cracked. The majority of projects show nearly 100% of the sections having some kind of cracking.

Figure 3 illustrates the relationship of cracking frequency and pavement age. The lack of correlation serves largely to reinforce the thinking that the cracking observed is based on more than normal aging.

Type 2 longitudinal cracks are defined in several of the references as load associated. Therefore, some correlation with traffic might be expected. Figure 4, illustrates the relationship between cracking frequency and 1967 average daily traffic. A trend exists which is better for transverse cracking than supposedly load associated cracking. The trend, however, indicates that cracking increases as traffic decreases. While it is likely that higher traffic may assist in keeping the asphalt surface "live" and workable, it is more strongly supported that pavement distress increases with cumulative traffic. A more significant approach would be that used in Utah (1); the use of cumulative 18 Kip axle loads as a dependent variable. In the Utah study, cumulative 18 Kip axle loads produced a mirror image of the Serviceability Index curve when plotted against age. Cracking would be expected to exhibit similar tendencies.

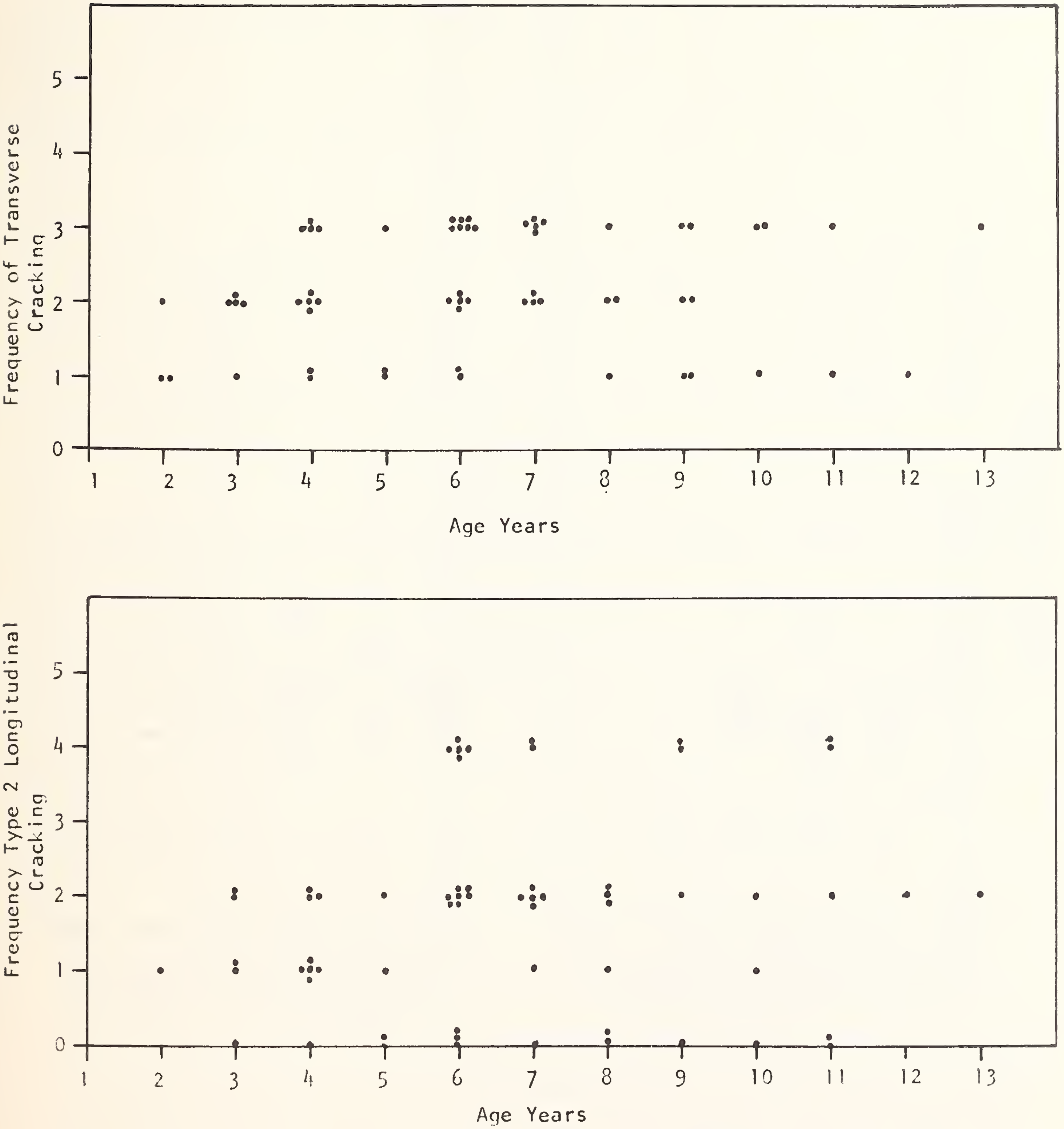


FIGURE 3. Comparison of Crack Frequency and Age for The Interstate System

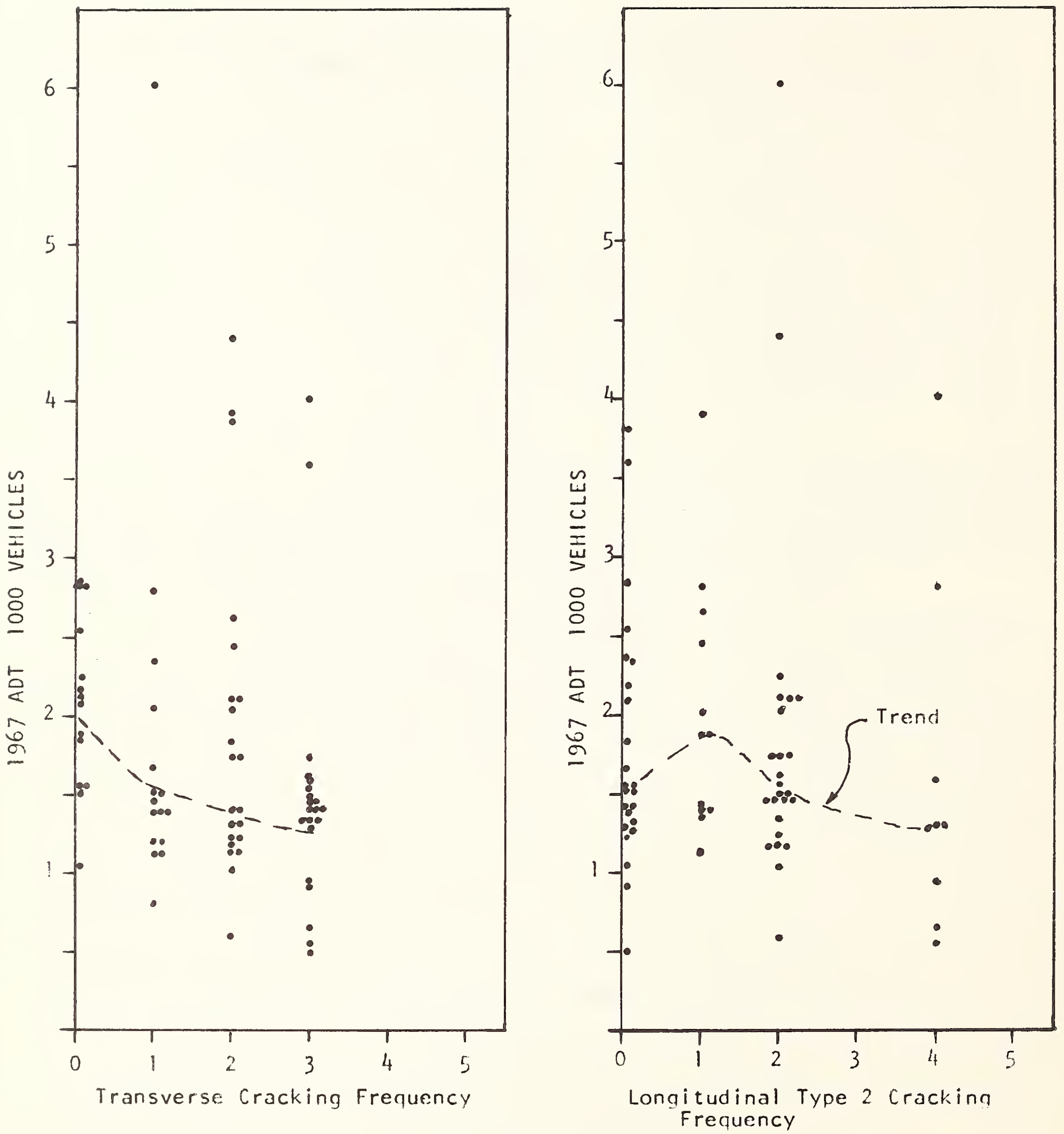


FIGURE 4. Comparison of Frequency of Cracking and Traffic - Interstate

The question has been raised whether the tighter gradation specification covering Type 3 plant mix is resulting in significantly less cracking than Type 2 mixes. Figure 5, illustrates frequency of transverse cracking versus mix type on the Primary system. Mean values indicate a slightly lower crack level on the Primary system for Type 3 mixes. This is inconclusive due to the number of variables such as traffic, geography geology, age, subgrade, and construction control which must be evaluated or held constant before a true relationship can be achieved. In addition, many of the Type 2 mixes may actually meet or nearly meet Type 3 specifications. Other distress factors, such as rutting, ravelling, or shoving may be more significant than cracking when compared to mix type. Within the scope of work to be accomplished, this avenue of investigation could not be pursued.

McLeod, 1968, (4) reiterated the findings of his past and continuing research into transverse cracking due to low temperature stresses in Canada. His contention is that hard asphalts are subject to premature transverse cracking. The cure is the use of softer asphalts coupled with a reduction in air voids within the compacted mix. During hot weather, other types of distress may or may not become more detrimental than cracking. The Primary highway system was used in Figure 6 to illustrate the relationship between transverse cracking frequency and penetration grade of asphalt cement. The lowest mean cracking level was for 85-100 penetration grade; however, none of the projects concerned were over 5 years old. More newer pavements contain 100-120 penetration asphalt than the 150-200 grade, and the mean cracking level is reduced somewhat when pavements 5 years old or newer are included. Pavements using 150-200 penetration asphalt exhibit a slightly lower cracking level than the 100-120 grade in both cases. The difference between means is not large and cannot be judged conclusive without more analysis.

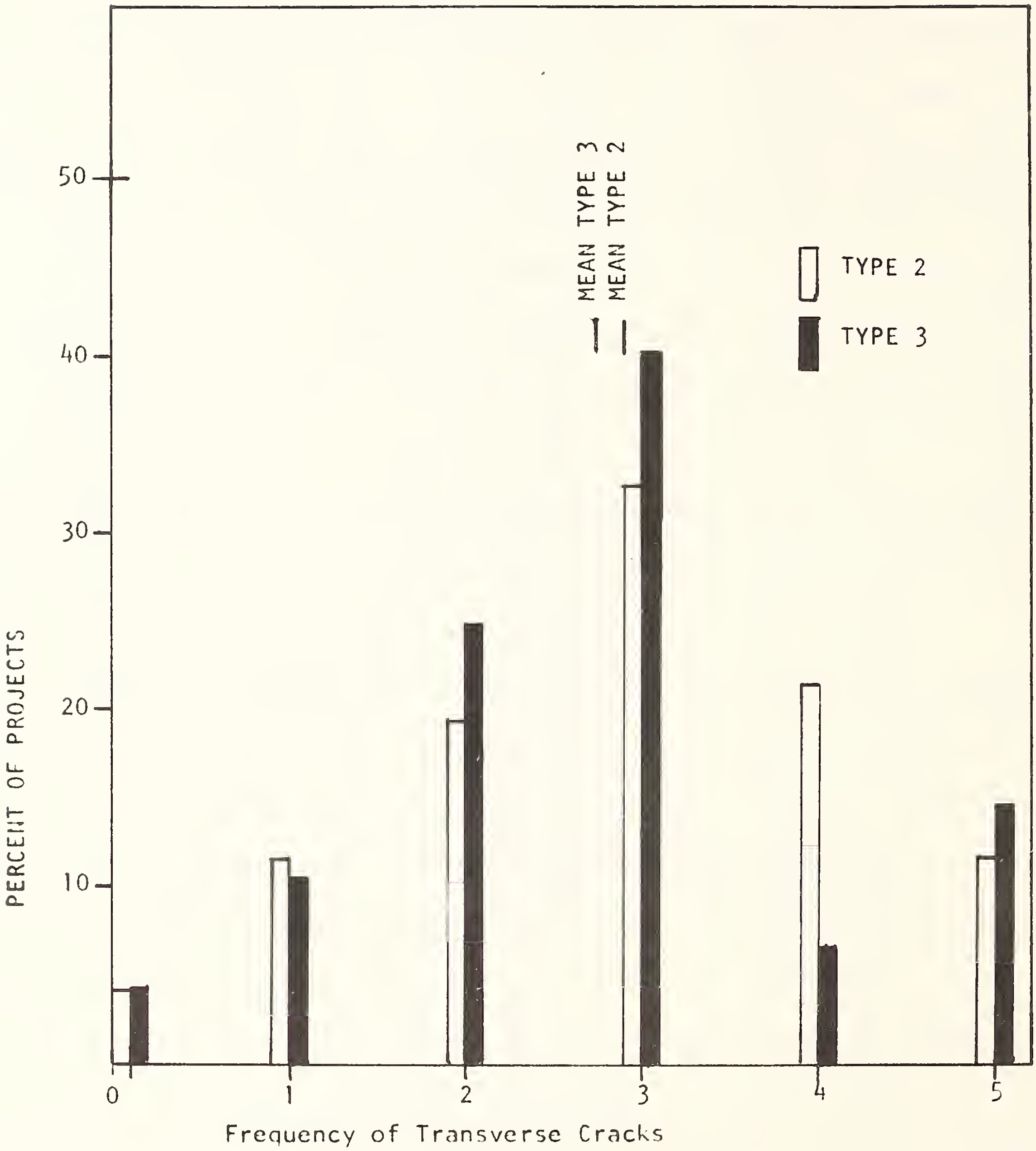
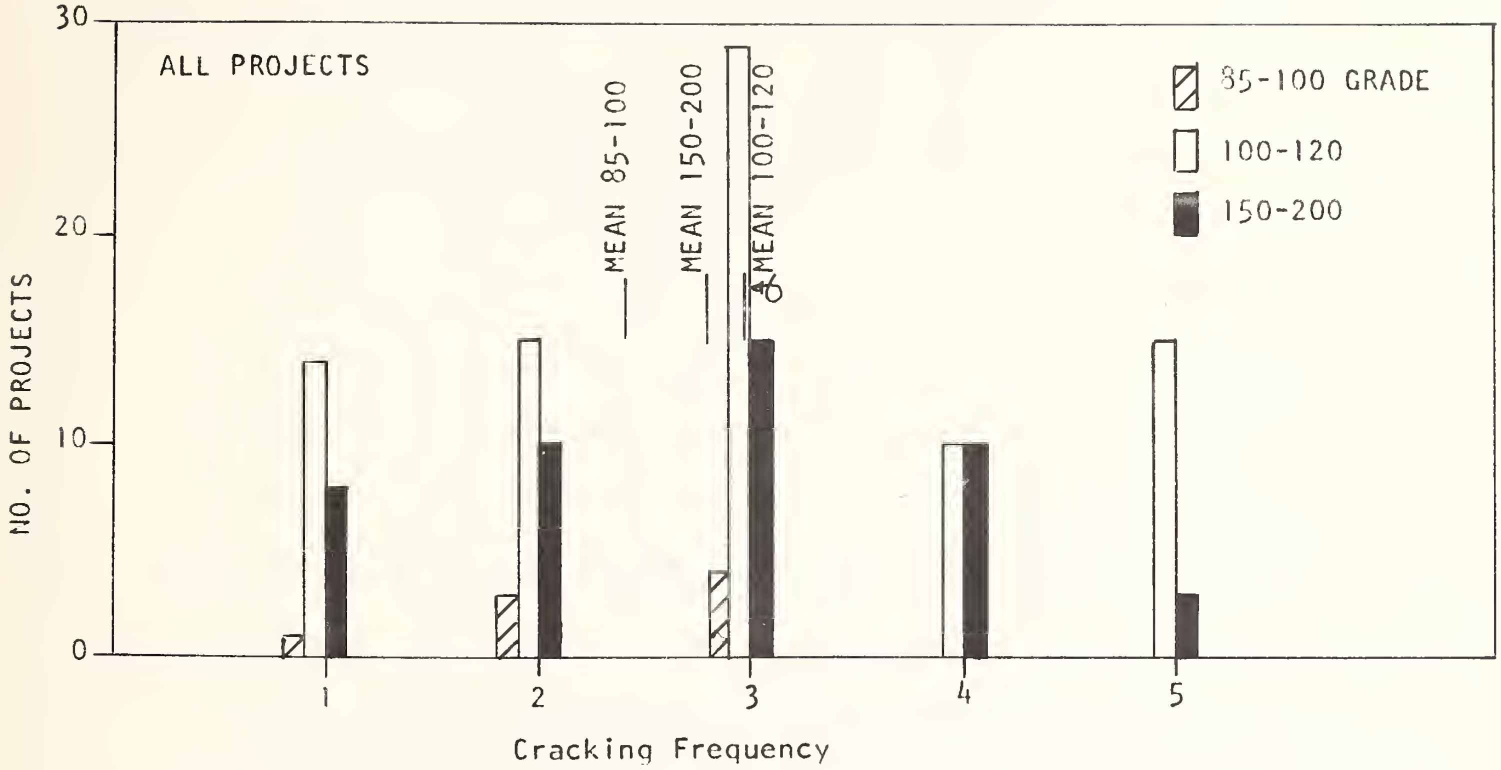


FIGURE 5. Frequency of Transverse Cracking Compared to Mix Type - Primary System



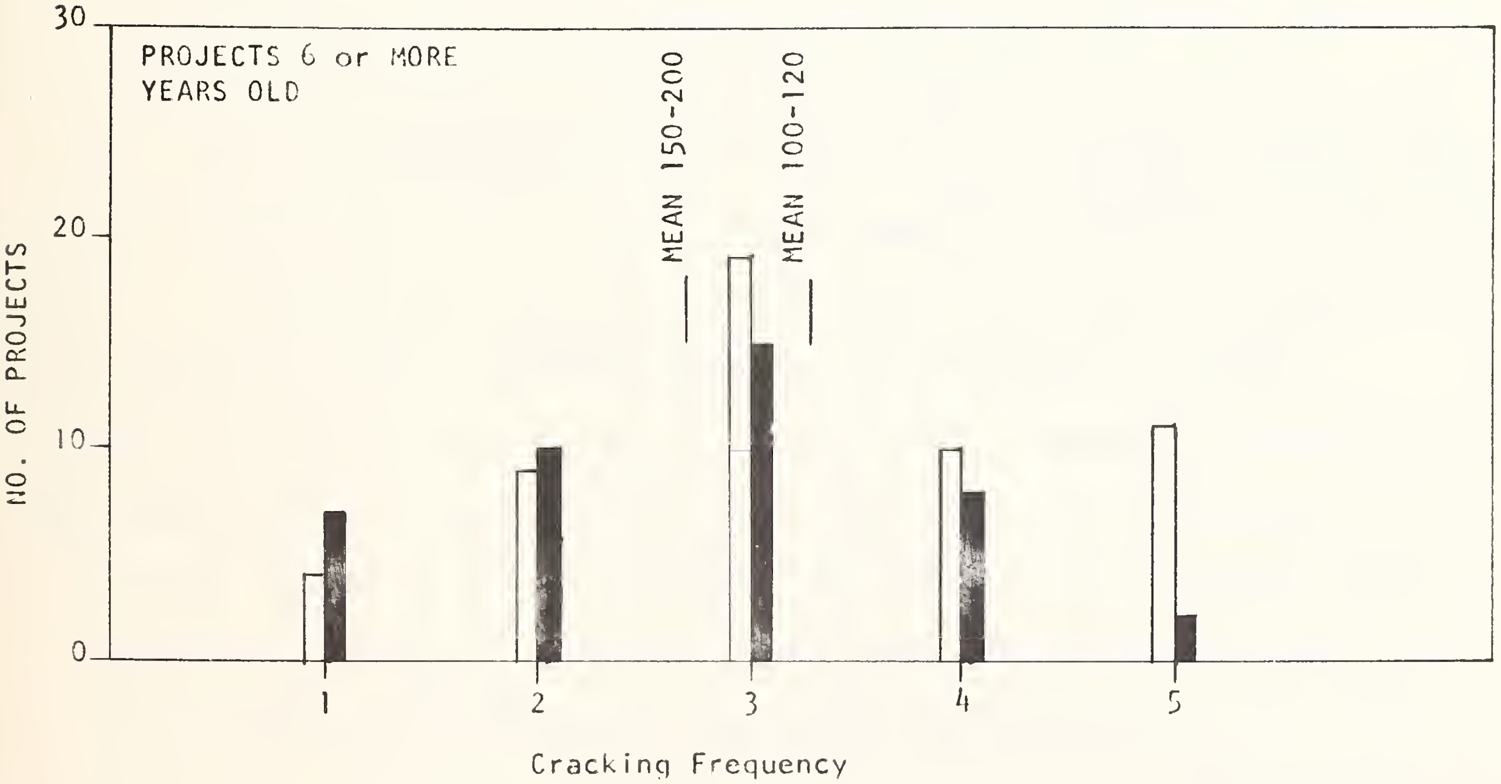
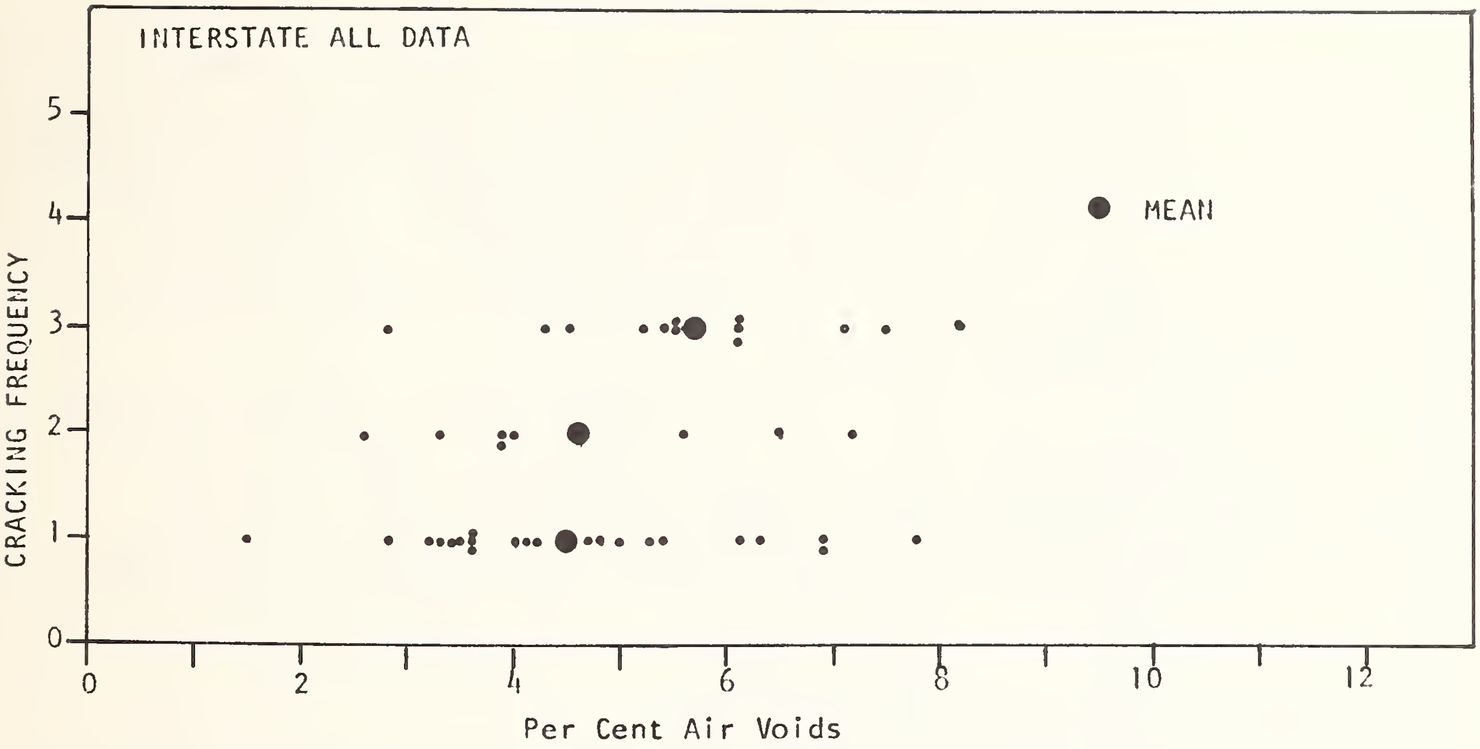


FIGURE 6. Comparison of Transverse Cracking Frequency and Penetration Grade of Asphalt Cement - Primary System

Properties of the asphaltic mixture are intuitively suspected in the investigation of cracking. Higher than optimum asphalt contents are significant in reducing cracking due to a lower modulus of elasticity and high air void contents contribute to cracking. Lamb, et al, 1967 (5) concluded that high air void content and high filler to asphalt ratios contribute to cracking. No absolute limits were set by the above study, but it was concluded that the filler to asphalt ratio became more critical as the stiffness of the asphalt increased. McLeod (4) suggests that air voids be held in the 3 to 4% range. Dust ratio and percent fines (passing 200 mesh sieve) are variable which would appear related to the filler to asphalt ratio.

Asphalt content was compared to crack frequency with negligible results. Whether a particular asphalt content is high or low is very dependent on the aggregate. If a project or projects using similar aggregates could be broken down into segments and the cracking frequency and field asphalt content compared, a more valid correlation may be achieved. Other variables are measures of the same relationship; voids are in part dependent on asphalt content, and in part dependent on construction quality.

Figure 7, illustrates the relationship between air voids and transverse cracking frequency. The correlation is poor and the variation is high. Only one value of voids content was listed for each project. Montana State Highway representatives indicated that the void values most probably represent laboratory values rather than actual field data. Without field information, any correlation between voids and cracking would be difficult, if not meaningless.



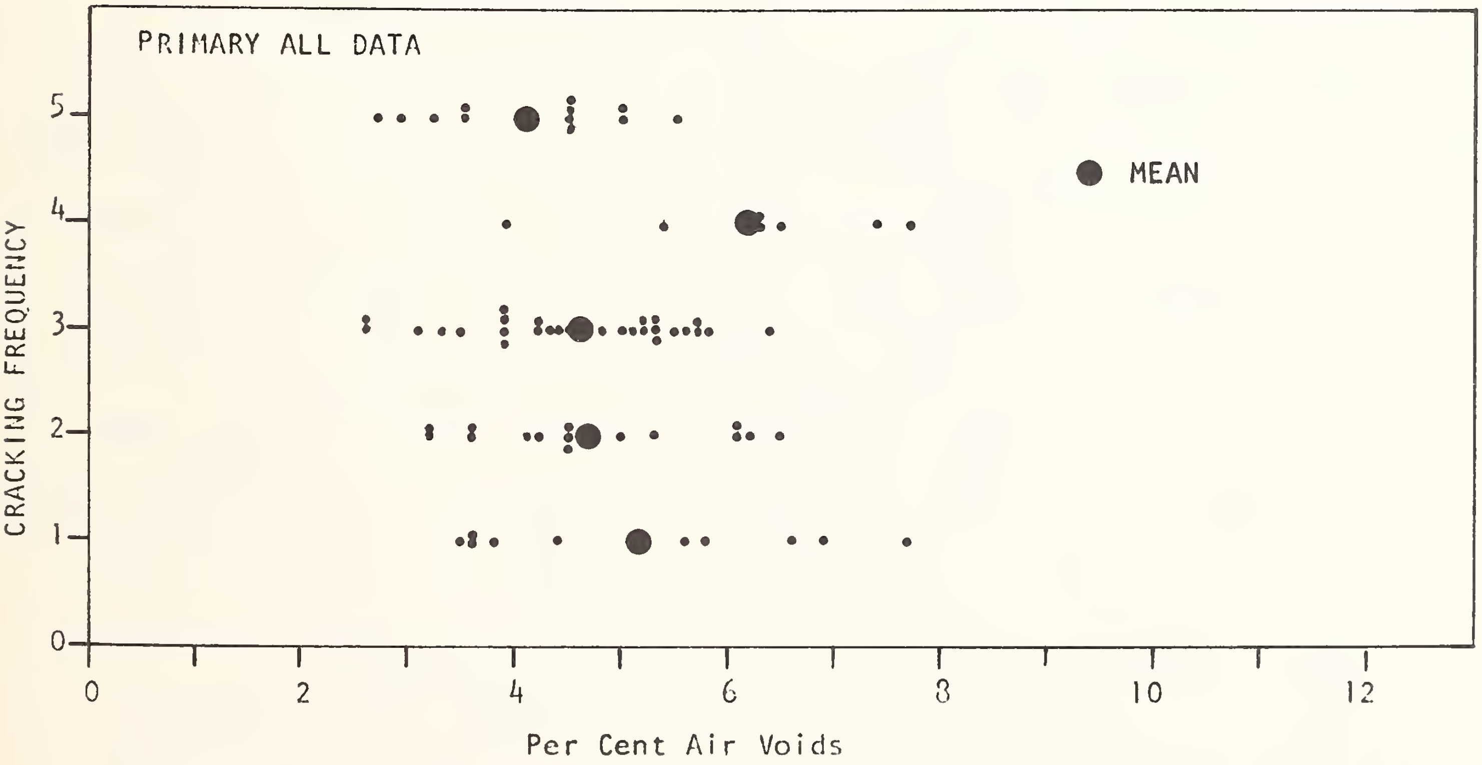


FIGURE 7. Comaprison of Transverse Cracking Frequency With Per Cent Air Voids

At this point the Interstate data was stratified into geographic-geologic areas, to at least in part account for differences in aggregate sources. Without the use of the individual quarter mile segments, the sample size is very small. As a result, the correlations may or may not be valid. Figure 8, is a map of Montana showing the approximate boundaries used to subdivide the State into six areas.

Figure 9, illustrates the relationship between laboratory air voids and transverse cracking frequency for selected areas on the Interstate System. Areas 2 and 3 show a good straight line correlation for the mean values. Variation is high, however. Area 5 shows a trend in the opposite direction, which is very unlikely.

Gradation and dust ratio values are most probably laboratory values, although the variation in percent passing the #200 sieve, and dust ratio between laboratory and field should be less than that for air voids. Figure 10, illustrates the relationship between transverse crack frequency, and percent finer than the 200 sieve, and dust ratio for the Interstate System. A trend appears to exist in each case indicating that cracking increases directly with percent minus 200 and dust ratio. A similar trend exists with longitudinal Type 2 crack frequency as shown in Figure 11. In both cases the variation is very high. Figure 12, illustrates the relationship of transverse cracking and dust ratio for three selected areas on the Interstate System. Area 2 shows a rather good correlation, while areas 1 and 5 correlate poorly. Figure 13, illustrates the relationship between transverse crack frequency, dust ratio, and percent finer than the 200 sieve for the Primary system. No significant trend appears to exist.

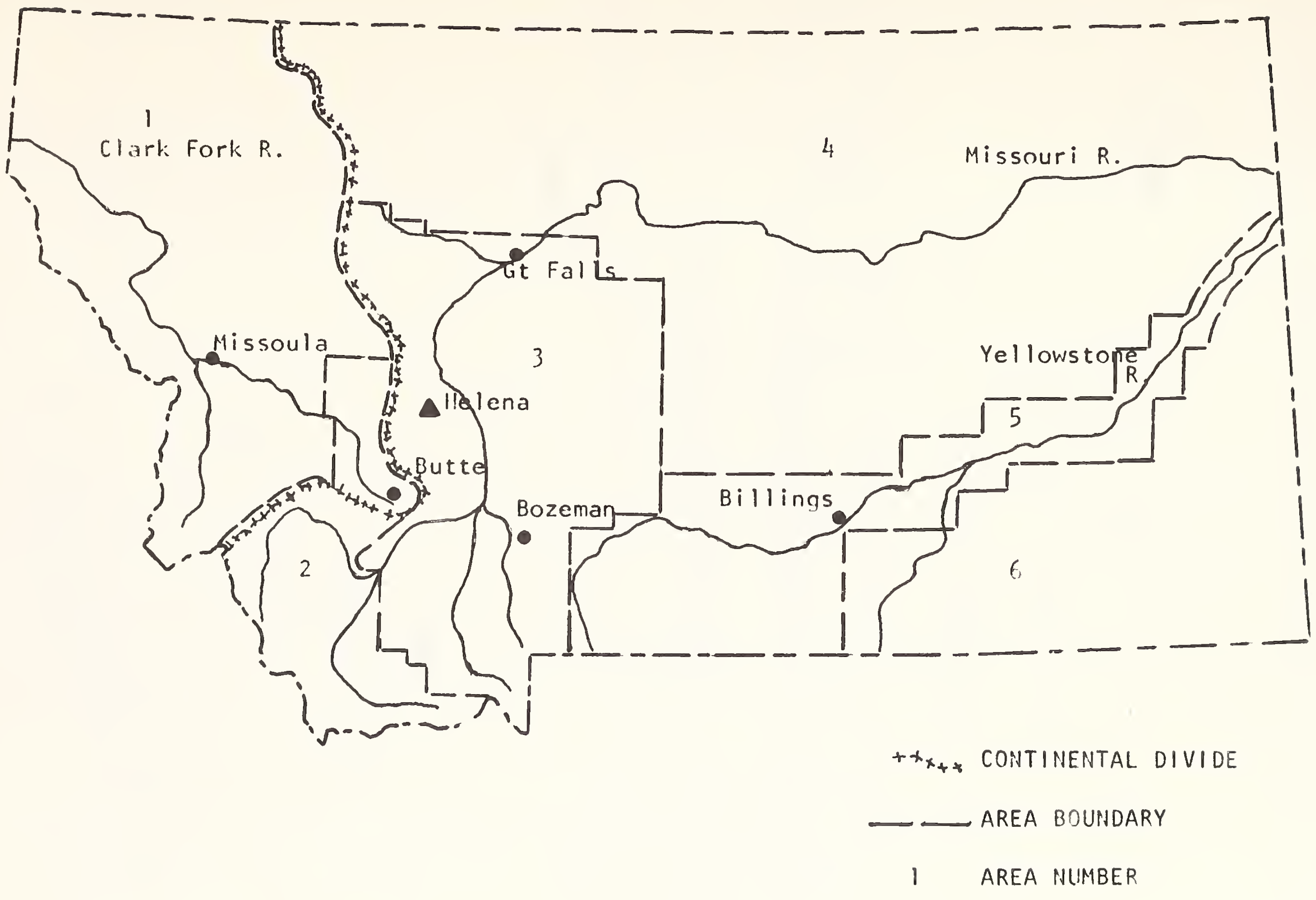


FIGURE 8. Map of Montana Showing Approximate Boundaries Used to Divide the Interstate System into Similar Geographic - Geologic Areas.

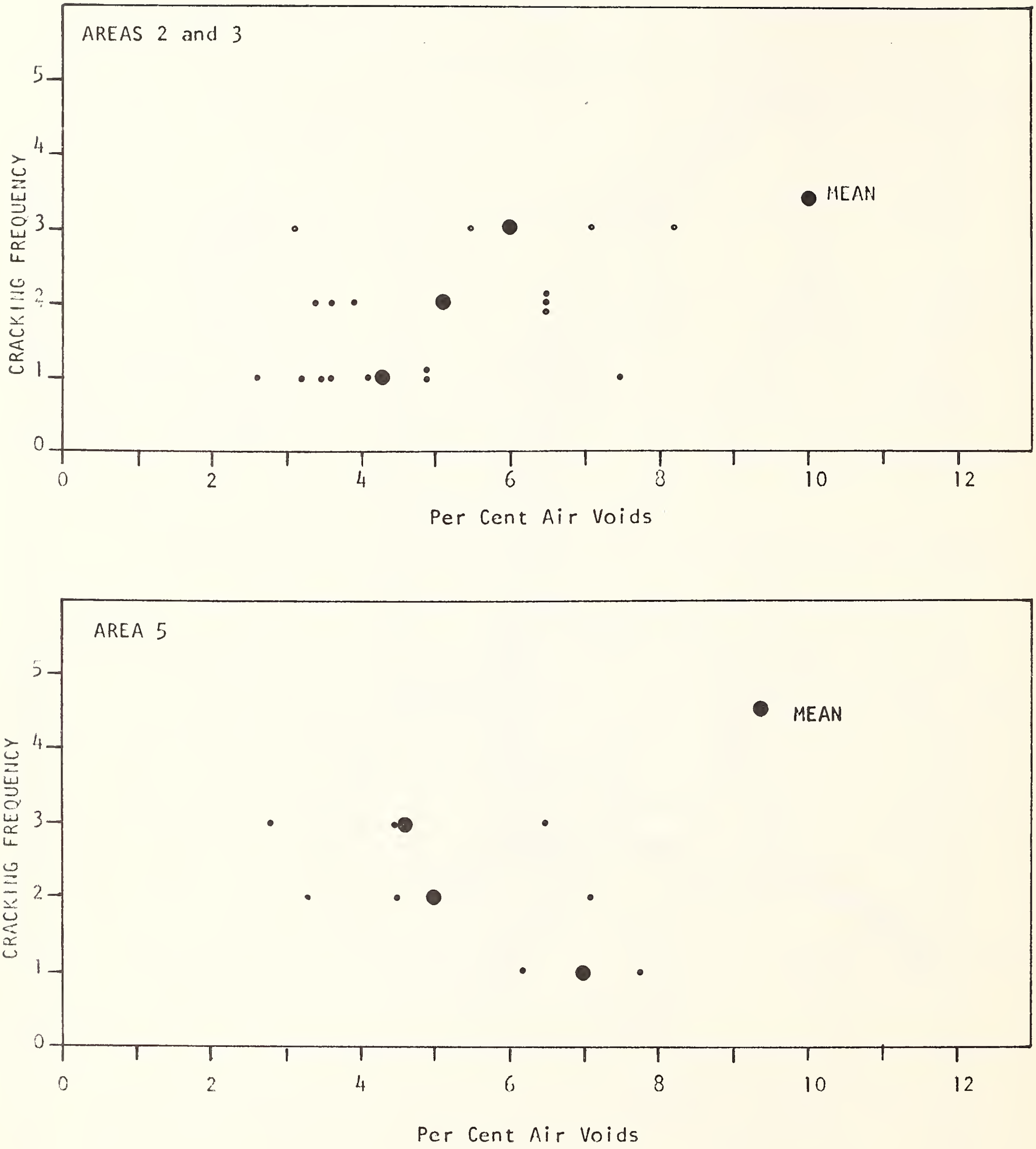


FIGURE 9. Comparison of Transverse Cracking Frequency with Per Cent Air Voids From Selected Interstate Projects.

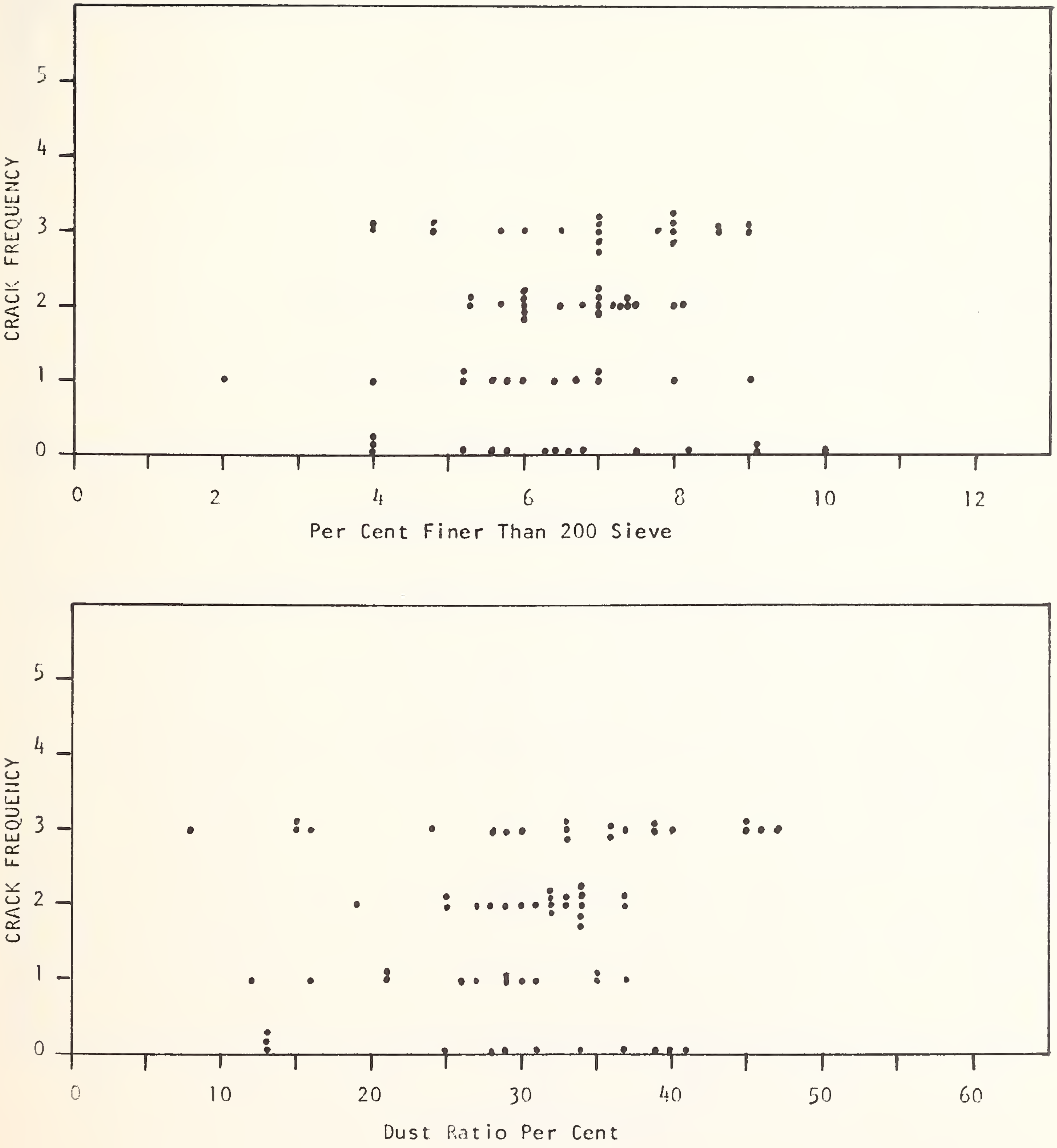


FIGURE 10. Comparison of Frequency of Transverse Cracking With Per Cent Finer Than 200 Sieve and Dust Ratio - Interstate System

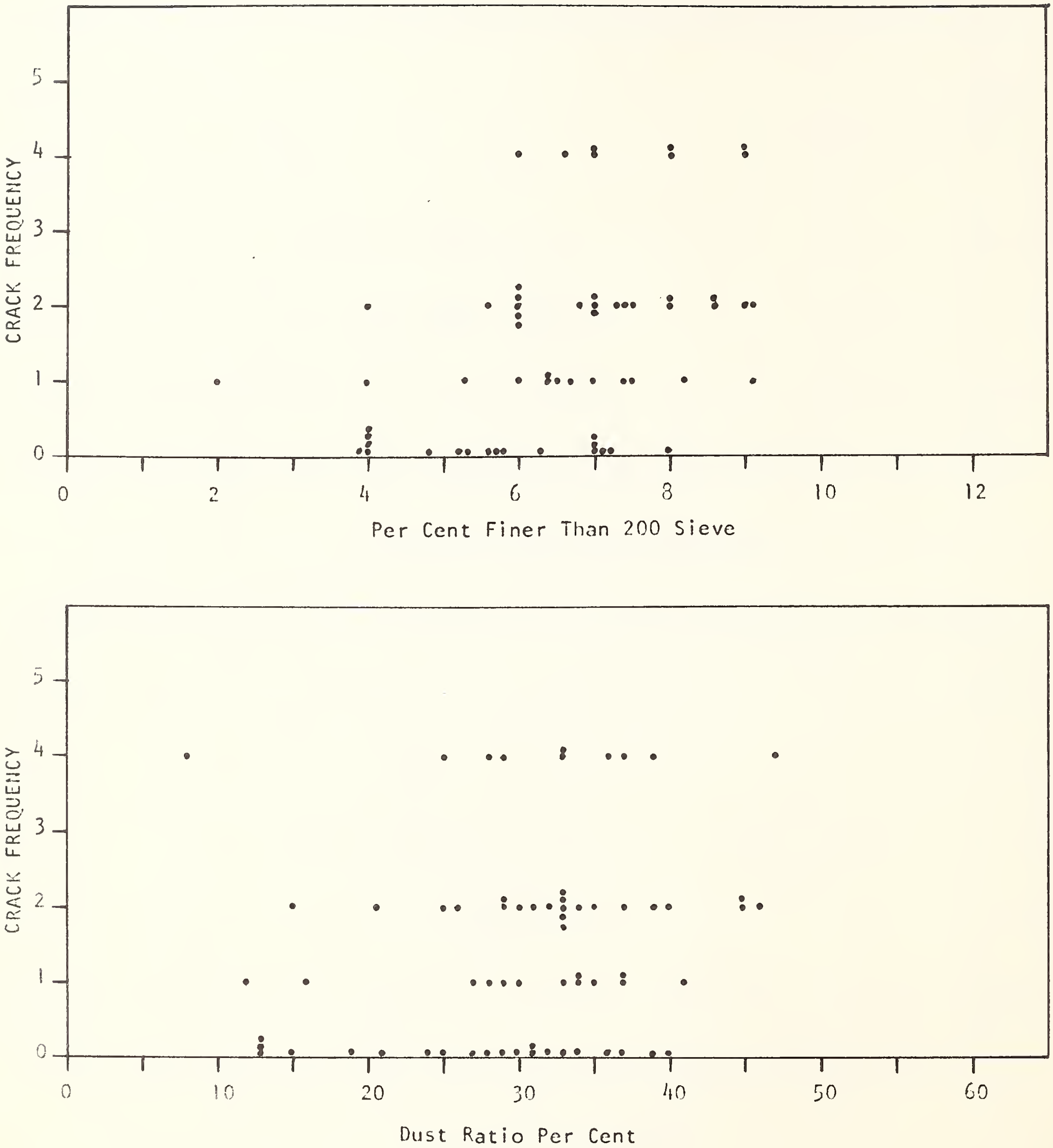


FIGURE 11. Comparison of Frequency of Type II Longitudinal Cracking With Per Cent Finer Than 200 Sieve and Dust Ratio - Interstate System.

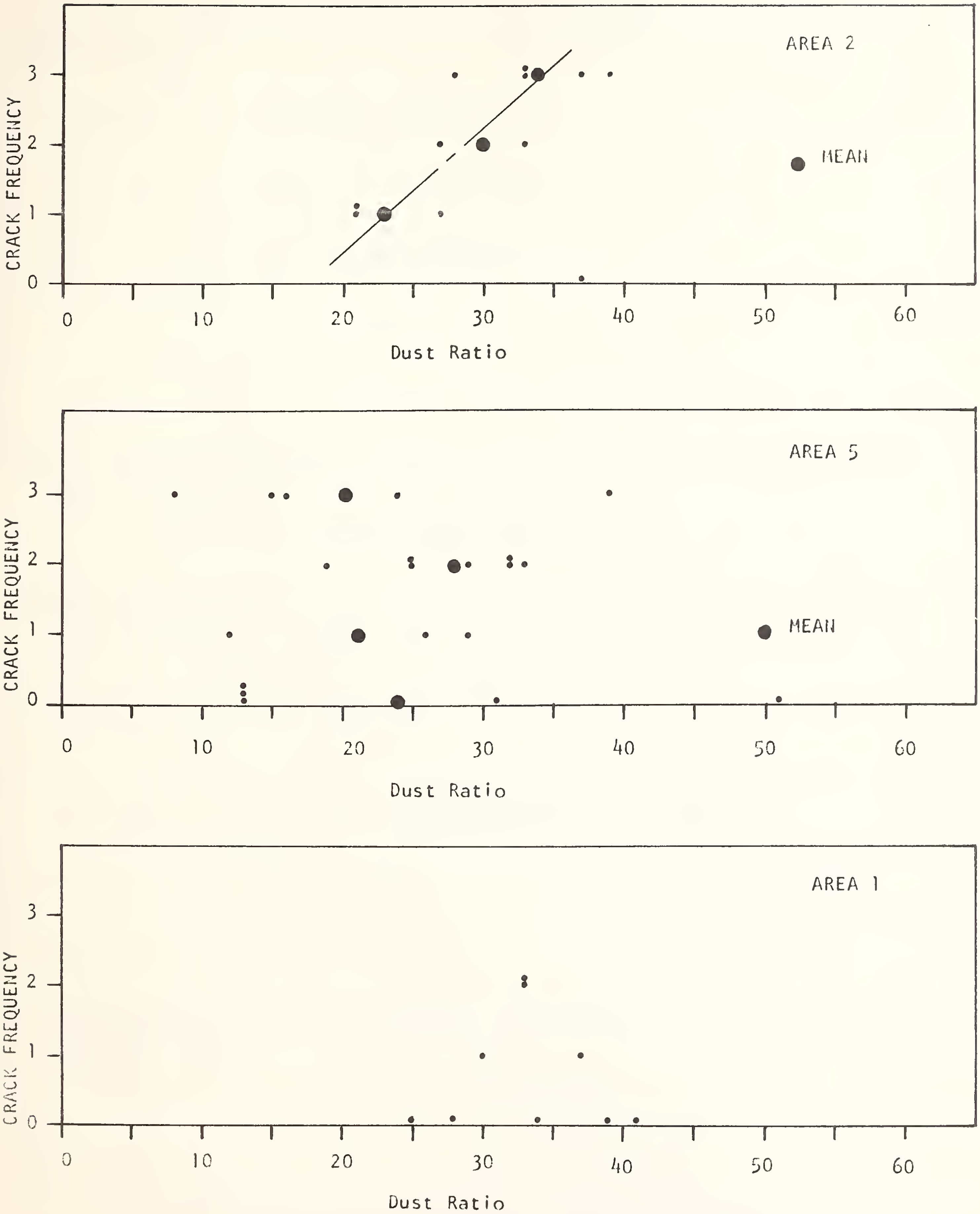


FIGURE 12. Comparison of Transverse Crack Frequency and Dust Ratio For Interstate Projects Selected Geographically.

NOTE: Only Projects Having 50% or more of the Study Sections Cracked are Included

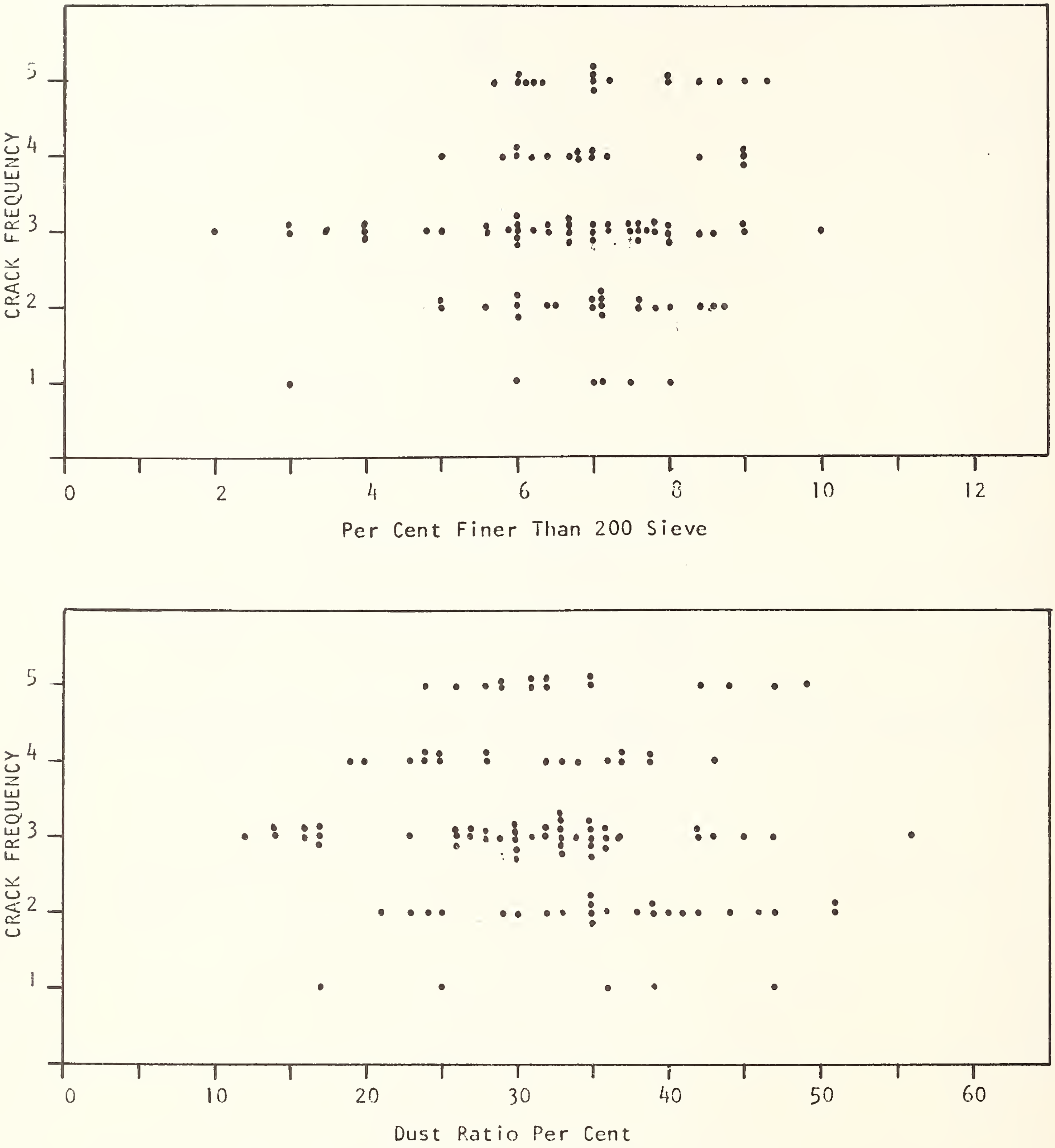


FIGURE 13. Frequency of Transverse Cracking Compared to Per Cent Finer Than 200 Sieve and Dust Ratio - Primary System.

Lamb (5) correlated high filler to asphalt ratios to transverse cracking. The filler used was minus 200 sieve material. Based on Lamb's findings, it was concluded that it was possible for the minus 200 sieve (fines) to asphalt content ratio to yield the same information. Figure 14, illustrates the relationship of crack frequency and fines to asphalt ratio. A trend exists indicating higher fines to asphalt ratios correlate with higher cracking frequency. The variation is very high, however. Figure 15, illustrates the same relationship for Area 5 (Yellowstone River) only. A rather good correlation is evident for longitudinal Type 2 cracking. Variation is very high for transverse cracking and the trend less clear.

Lamb (5) indicates high phenol penetration index in asphalt cement after column oxidation has been associated with poor pavement performance. Winnitoy, 1968, (3) indicates that high parafin contents in asphalt cement increases shrinkage and reduces cohesive strength, possibly increasing cracking.

There is an indication from the data available in this investigation that some sources of asphalt are associated with higher levels of cracking, but in light of the other correlations, this is not judged conclusive.

Several variables, which are felt to be important, were not included in the data: whether the section was in cut or fill, moisture-density relations and character of the subgrade, and moisture-density information for granular base.

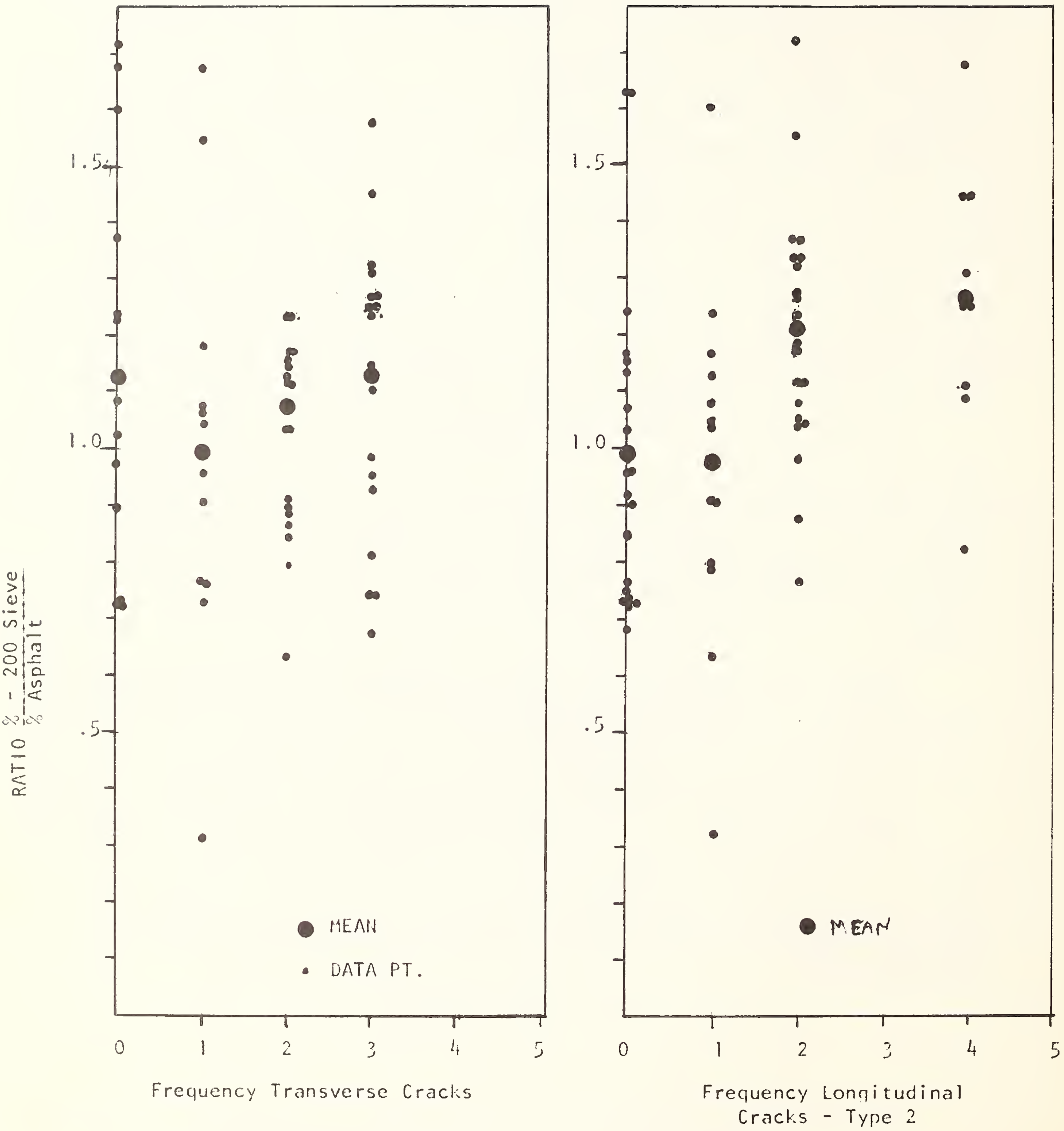


FIGURE 14. Frequency of Cracking Vs. Ratio of Minus 200 Material To Asphalt Content - Interstate System.

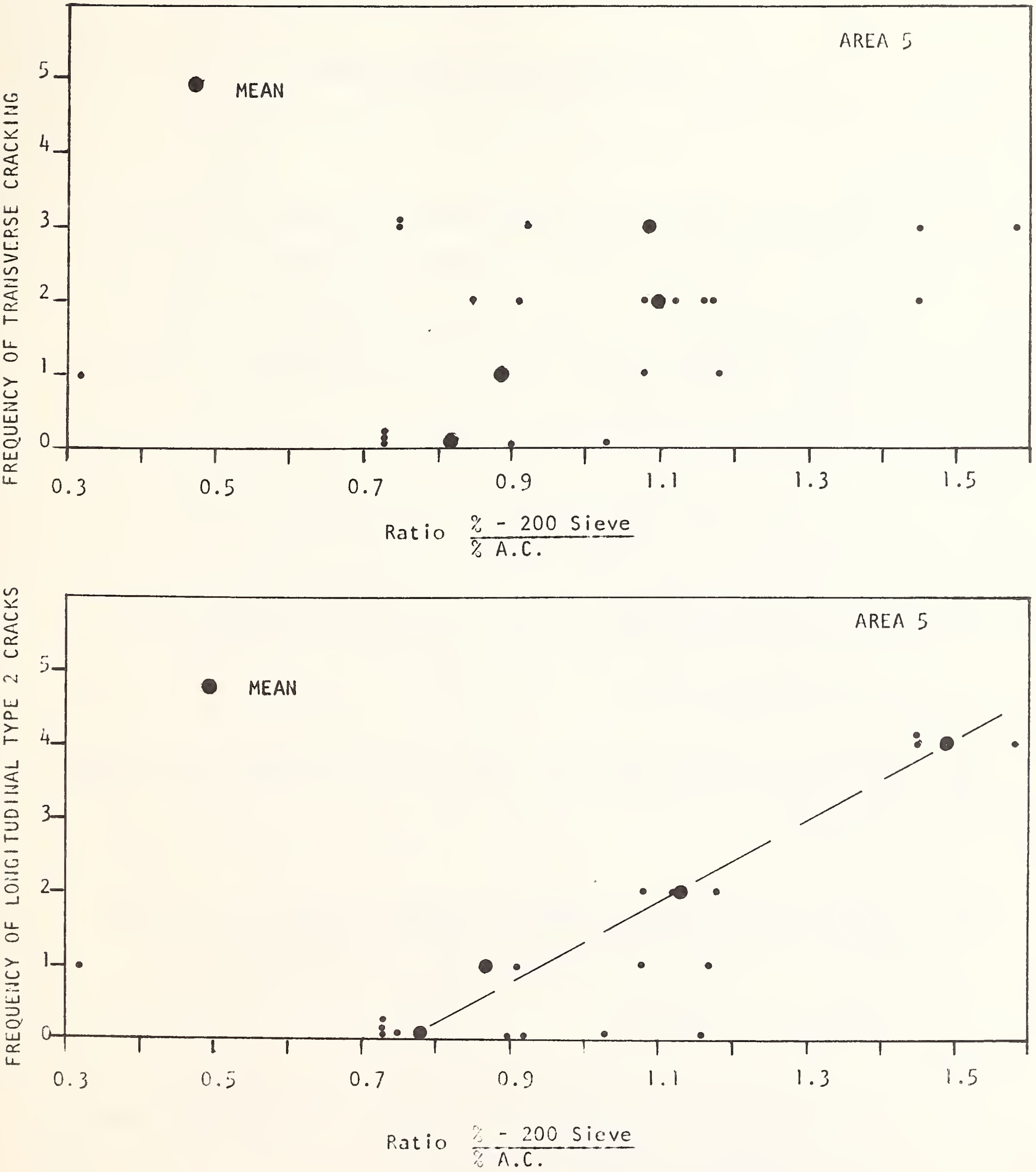


FIGURE 15. Comparison of Cracking Frequency and Ratio of Per Cent Finer Than 200 Sieve to Per Cent Asphalt - Selected Interstate Projects.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS:

1. Trends exist which indicate that parameters such as field void content, dust ratio, fines to asphalt ratio, asphalt source and asphalt penetration influence premature cracking of pavements in Montana. All of the above have been cited as important in explaining cracking by previous researchers.

2. Few of the correlations achieved were conclusive.

3. The rating system does not exhibit sufficient variation to be applicable as a measure of cracking.

4. The lack of field test data reduces the significance of the trends observed.

5. After stratification of data to eliminate variables such as age, traffic and geography, the sample size is insufficient to be statistically adequate.

6. The data gathered to date will be valuable in continuing research, when supplemented by additional testing.

RECOMMENDATIONS:

1. Research be continued under a two phase approach.

2. Under phase one, a few project pairs are recommended to be picked for detailed sampling and testing. The choice of projects should be made to include a relatively uncracked and a severely cracked pavement in each pair. Variables such as traffic, age, climate, and general geographic-geologic location should be held constant within a pair if possible.

   Field tests be sufficient in each test section to provide statistically significant samples. The types of tests performed should be adequate to evaluate the variables present in the entire paving section, including the subgrade.

   Benkelman Beam deflection tests should be included in the field program to provide correlations of load carrying capacity, deflection, and cracking between test sections.

   A detailed crack measuring study is recommended to be made on the selected test sections as a check on the field study made in conjunction with this report, and to provide a measure of the change in cracking frequency.

   A complete search of the construction records should be made for the selected projects and the data compiled for correlation with field test results.

3. Phase Two is recommended as an expansion of phase one to other areas of the state, if significant results are produced in phase one.

4. The method of recording crack frequency be expanded to allow a larger number of frequency groups, and any future rating method be made a relative type allowing a greater variation between upper and lower limits, unless a present serviceability rating is desired.

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APPENDIX

The appended material consists of the following:

Pgs. 1 & 2 - Field rating sheet for I-15-4(9)194 illustrating methods of crack measurement recording.

Pg. 3 illustrates the 5 card data storage format for I-15-4(9)194.

Pg. 4 illustrates - Field rating sheet for F-270(10).

3-23-76
176[illegible]

PROJECT I.D. 143 PROJECT No. I-15-4(8)194 LENGTH 12.663 (miles) ROUTE I-1 2L ___ E.B. ___ W.B. ___ S.B ___ N.B. ___

RIDE 0 Very Poor 1 Poor 2 Fair [✓ 3] Good 4 Very Good 5 AGE OF PAVEMENT ___ YEARS

SURFACE APPEARANCE 0 ___ 1 ___ 2 ___ 3 c 4 ___ 5 SEALED ___

Mile Post 205.334	0				1				2				3				4				5				6				7				8
CRACKED SUBGRADE																																	
TRANSVERSE	4/2	3/2	3/2	3/2	2/2	2/2	2/2	2/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	3/2	3/2	3/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	
LONGITUDINAL TYPE 1					4/2	3/2	3/2																										
TYPE 2	1/2	2/2	1/2	1/2	1/2	1/2	1/2	1/2	1/1	1/1	2/2	2/2	2/2	2/2	1/2	1/2	1/2	1/2	1/2	1/2	3/2	3/2	3/2	3/2	2/2	2/2	3/2	3/2	3/2	3/2	3/2	3/2	
ALLIGATOR																																	
LADDER																																	
RAVELLING	✓																																
RUTTING																																	
CORRUGATIONS																																	
SETTLEMENT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
WATER IN ROADBED																																	
WATER ALONG ROADWAY																																	

REMARKS

3-23-76

PROJECT I.D. 143 PROJECT No. I-15-4(9)194 LENGTH 12.663 (miles) ROUTE I-15 2L __ E.B. __ W.B. __ S.B. __ N.B. __

RIDE 0 Very Poor 1 Poor 2 Fair [✓ 3] Good 4 Very Good 5 AGE OF PAVEMENT __ YEARS

SURFACE APPEARANCE 0 __ 1 __ 2 __ 3 ~~6~~ __ 4 __ 5 SEALED __

Mile Post	~~0~~ 8				~~1~~ 9				2 10				~~3~~ 11				~~4~~ 12				5				6				7			8
CRACKED SUBGRADE																																
TRANSVERSE	2 2	2 2	3 2	3 2	5 2	4 2	4 2	3 2	3 2	3 2	3 2	2 2	2 2	2 2	2 2	2 2	2 2	2 2														
LONGITUDINAL TYPE 1	5 2	5 2	5 2	5 2	5 2	5 2	5 2	5 2	4 2	4 2	4 2	4 2	4 2	4 2	4 2	4 2	4 2	4 2														
TYPE 2		2 2																														
ALLIGATOR																																
LADDER																																
RAVELLING																																
RUTTING																																
CORRUGATIONS																																
SETTLEMENT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓														
WATER IN ROADBED																																
WATER ALONG ROADWAY																																

REMARKS

PAVEMENT CRACKING

PROJECT IDENT	PROJ CODE	PROJECT NO.	LENGTH MILES	ROUTE	RIDE	APPEAR.	SEALED	BEGIN MILE POST	DATE OBSERVED			CRACKING														DATE PAVED	
									MO.	DAY	YR.	TRANSVERSE NO.	TRANSVERSE FREQ. %	LONGITUDINAL TYPE I NO.	LONGITUDINAL TYPE I %	LONGITUDINAL TYPE II NO.	LONGITUDINAL TYPE II %	ALLIGATOR	LADDER	RAVELLING	RUTTING	CORRUGATION	SETTLEMENT	WATER IN [illegible]	WATER ALONG ROADWAY	MO.	YR.
571	1	F-15-4(9)194	127	F15	32	35	1	2054	06	19	70	3	100	1	090	2	020	000	000	070	000	000	100	000	000	09	63

ASPHALT

MIX						PRIME		TACK		ADDITIVES		DESCRIPTION				
GRADE I	SUPPLIER	%	GRADE II	SUPPLIER	%	GRADE III	SUPPLIER	GRADE IV	SUPPLIER		%		GRADE I	GRADE II	GRADE III	GRADE III
100-120	7	0607				MC-1	7	RC-1	7	2			~~12~~	~~00~~	~~31~~	~~21~~

1200 31 21 571

PLANT MIX AGGREGATE

GRADATION									DUST RATIO %	FRACTURE %	VOLUME SWELL	ADESION	SOURCE						MINERAL FILLER						
NO.	3/4	1/2	3/8	4	10	40	80	200					PIT NO.		PIT NO		PIT NO.		TYPE	SUPPLIER	QUAN %	TYPE	SUPPLIER	QUAN %	
2	100	095	086	055	032	013	000	060	46				226320	22					2	24	10				571

MIX							SURFACE TREATMENT										
MARSHAL RESULTS			TEMPERATURE														
VOIDS %	FLOW	STABILITY	MIX LOW	MIX HIGH	AIR LOW	AIR HIGH	MONTH	YEAR	GRADE V	SUPPLIER	MONTH	YEAR	GRADE VI	SUPPLIER		GRADE V	GRADE VI
																5	71

SUBGRADE						SURFACING													FEATURES				REMARKS
FOUNDATION						BASE SIZE INCHES	1ST CRSE		2ND CRSE		TOP		CUSHION		TOTAL DEPTH IN INCHES	MAT THKNESS INCHES	NO. OF LIFTS	LEVELING COURSE	TRAFFIC				
CLAY	GRAVEL	SILT	SAND	ROCK	OTHER		TYPE	SIZE INCHES	TYPE	SIZE INCHES	TYPE	SIZE INCHES	TYPE	SIZE INCHES					ADT	YR	ADT	YR	
							A	300	A	150	A	075			2100	420	2		01271	61	01586	67	571

PROJECT I.D. 471 PROJECT No. F-270(10) LENGTH 7.319 (miles) ROUTE 5 2L __ E.B. __ W.B. __ S.B. __ N.B. __

RIDE 0 — Very Poor — 1 — Poor — 2 — Fair — 3 — Good ~~6~~ — 4 — Very Good — 5 3.7

APPEARANCE 0 —— 1 —— 2 —— 3 —X— 4 —— 5 3.4

DATE 7/28/70

SEALED yes

MILE POST 112.964	0				1				2				3				4				5				6			7	SUMMARY No.	%
TRANSVERSE - FREQUENCY	1	2	3	2	2	2	2	2	2	3	2		2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	100
WIDTH	1	1	1	1	1	2	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	—
LONGITUDINAL TYPE 1			✓	✓	✓		✓		✓		✓	✓			✓			✓				✓	✓	✓	✓	✓	✓	✓		56
TYPE 2			2	4	4					2	2	4			4			2			2	4	4	2	4	4	4	4	2	56
ALLIGATOR				✓											✓												✓			10
LADDER																														
RAVELING															✓									✓			✓	✓		10
[illegible]															✓							✓	✓		✓		✓		—	17
[illegible]																														
SETTLEMENT	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓			✓		✓	✓		✓	✓	✓	✓	✓			✓	✓		70
WATER IN ROADBED																														
WATER ALONG ROADWAY																											✓	✓		7

REMARKS

FREQUENCY OF LONGITUDINAL CRACKING

1 - 1 crack per 2 lane width
2 - 1 " per lane
3 - 1 crack per lane - interlaced or tendrils
4 - Multiple
5 - Severe

FREQUENCY OF CRACKING - TRANSVERSE	No.
1 crack or more every 10'	5
" 10'-20'	4
" 20'-100'	3
" 100'-500'	2
NEGLIGIBLE CRACKING	1

WIDTH OF CRACKS	No.
HAIRLINE to 1/8"	1
1/8" — 3/8"	2
3/8" OR GREATER	3

LONGITUDINAL	
#1	CONSTRUCTION JOINT
#2	NON-CONSTRUCTION JOINT